Smart Grid Standards Information

Version 1.6
Thursday, September 30, 2010

Section I: Use and Application of the Standard

A. Identification and Affiliation

1.	Number of the standard	IEC 61850
2.	Title of the standard	Communications Networks and Systems for Power Utility Automation
3.	Name of owner organization	International Electrotechnical Commission
4.	Latest versions, stages, dates	Edition 1 of most parts released 2003-2005 Edition 1 of Hydroelectric and DER models released 2009 Edition 2 of Part 6 and Part 7-4 released 2009-2010 Edition 2 of most other parts planned for 2010
5.	URL(s) for the standard	www.iec.ch
6.	Working group / committee	Working Group 10 – Core specifications Working Group 16 – Hydroelectric models Working Group 15 – Security Working Group 17 – Distributed Energy Resource models
7.	Original source of the content (if applicable)	Core parts prepared based on EPRI Research Project, IEEE Technical Report on Utility Communications Architecture; IEC 60870-5
8.	Brief description of scope	Provides self-describing, object-oriented access to substation data and functions plus high-speed channels for protection tripping and waveform transfer over local area networks. Originally designed for substation automation only, the scope of this standards family has recently been expanded to include substation-to-substation communication and substation-to-control-center communications. The object modeling methodology has been used to expand the original substation data definitions include distributed generation, hydro power and wind power models.

B. Level of Standardization

1.	Names of standards development organizations that recognize this standard and/or accredit the owner organization	IEC, ISO, IEEE
2.	Has this standard been adopted in regulation or legislation, or is it under consideration for adoption?	☐ Yes ☐ No #####

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3.	Has it been endorsed or recommended by any level of government? If "Yes", please describe	☐ Yes ☐ No #####
4.	Level of Standard (check all that apply)	☒ International ☐ National ☐ Industry ☐ de Facto ☐ Single Company
5.	Type of document	☒ Standard ☐ Report ☐ Guide ☐ Technical Specification
6.	Level of Release	☒ Released ☐ In Development ☐ Proposed

C. Areas of Use

1.	Currently used in which domains? (check all that apply)	☐ Markets ☐ Operations ☐ Service Providers ☒ Generation ☒ Transmission ☒ Distribution ☐ Customer
2.	Planned for use in which domains? (check all that apply)	☐ Markets ☒ Operations ☐ Service Providers ☐ Generation ☐ Transmission ☐ Distribution ☐ Customer
3.	Please describe the Smart Grid systems and equipment to which this standard is applied	Substation automation including protection, control, monitoring and substation metering, fault recording, Volt/VAR optimization, equipment monitoring, generation, distribution automation, interlocking and many other applications

D. Relationship to Other Standards or Specifications

1.	Which standards or specifications are referenced by this standard?	ISO/IEC 7498 OSI Model ISO/IEC 8824/8825 ASN.1 ISO/IEC 8822/8823/9576 Presentation Services and Protocols ISO/IEC 8326/8327/9458 Session Services and Protocols ISO/IEC 8072/8073/8602 Transport Services and Protocols ISO/IEC 8348/8473 Network Services and Protocols ISO/IEC 8649/8650/10035 ACSE ISO/IEC 8802-3 Local and Metro Area Networks CSMA/CD (Ethernet, IEEE 802.3) ISO/IEC ISP 11188 Minimal OSI upper layers ISO/ISP 9506 Manufacturing Message Specification (MMS) ISO/ISP 14226 MMS Profiles RFC 793 TCP RFC 768 UDP Various other IETF standards related to TCP and UDP RFC 1006 ISO Transport Services on top of TCP RFC 2030 Simple Network Time Protocol IEC 62351 Data Communications Security in Power Systems Many others
2.	Which standards or specifications are related to this standard?	IEC 61968 / IEC 61970 CIM standards will interface

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3.	Which standards or specifications cover similar areas (may overlap)?	Distributed Network Protocol (DNP3) IEC 60870-5 Telecontrol Modbus Hundreds of proprietary protocols
4.	What activities are building on this work?	IEC 61400-25 Wind Power IEC 61850-7-4xx series, new applications like distributed generation IEC 61850-80 series – interfaces with other protocols/domains

E. Dept of Energy Smart Grid Characteristics

Please describe how this standard may encourage each of the following:

1.	Enables informed participation by customers	☐ Yes ☒No Does not interact with customers
2.	Accommodates all generation and storage options	☒ Yes ☐ No Is being expanded to include object models for distributed and renewable generation. Can be expanded for almost any application.
3.	Enables new products, services and markets	☒ Yes ☐No non conventional sensors with digital interface;
4.	Provides the power quality for a range of needs	☒Yes ☐ No Includes power quality monitoring models
5.	Optimizes asset utilization and operating efficiency	☒Yes ☐ No Includes equipment (transformer, breaker) monitoring models
6.	Operates resiliently to disturbances, attacks, and natural disasters	☒ Yes ☐ No Based on reliable ISO and IETF transport profiles and includes specifications for redundancy, performance targets, and electrical network protection

F. Priority Areas Previously Mentioned by FERC and NIST

Please describe if and how this standard may be applied in each of the following areas. Note that there is space in section J to discuss any other significant areas where the standard may be applied.

1.	Cybersecurity and physical security	☒ Yes ☐ No
		Methods available using IEC 62351 to provide authenticated and encrypted data communications services
2.	Communicating and coordinating across inter-system interfaces	☒ Yes ☐ No
		Standards underway for substation-to-substation and substation-to-control-center communications (IEC 61850-90)
3.	Wide area situational awareness	☒ Yes ☐ No
		Standards underway for substation-to-substation and substation-to-control-center communications (IEC 61850-90). Standards being developed along with IEEE C37.118 to use IEC 61850-8-1 and IEC 61850-9-2 for phasor measurement communications
4.	Smart grid-enabled response for energy demand	☒ Yes ☐ No
		Based on IEC 61850-7-420 and planned extensions communication to energy generation as well as to controllable load / storage (e.g. electrical vehicles) possible
5.	Electric storage	☒ Yes ☐ No
		Work underway to expand models to include electric storage.
6.	Electric vehicle transportation	☐ Yes ☒ No
		Extensions planned; pilot projects in preparation
7.	Advanced metering infrastructure	☐ Yes ☒ No
		May include models for customer metering in the future.
8.	Distribution grid management	☒ Yes ☐ No
		Applicable to both transmission and distribution substations. Work underway to address feeder automation specifically.

G. Openness

1.	Amount of fee (if any) for the documentation	CHF 3319 (Swiss Francs) for complete Edition 1 set, approx US$3000
2.	Amount of fee (if any) for implementing the standard	0
3.	Amount of fee (if any) to participate in updating the standard	0
4.	Is the standard documentation available online?	☒ Yes ☐ No http://webstore.iec.ch
5.	Are there open-source or reference implementations?	☐ Yes ☐ No Status uncertain. One was attempted.
6.	Are there open-source test tools?	☒ Yes ☐ No EtheReal/WireShark
7.	Would open-source implementations be permitted?	☒ Yes ☐ No
8.	Approximately how many implementers are there?	communication stacks: a few Products: all significant vendors support it
9.	Approximately how many users are there?	Several hundreds
10.	Where is the standard used outside of the USA?	Extensively in many places around the world; on the way to be adopted almost everywhere
11.	Is the standard free of references to patented technology?	☒ Yes ☐ No
12.	If patented technology is used, does the holder provide a royalty-free license to users of the standard?	☐ Yes ☐ No ☒ Not Patented
13.	Can an implementer use the standard without signing a license agreement?	☒ Yes ☐ No
14.	Are draft documents available to the public at no cost?	☐ Yes ☒ No
15.	How does one join the working group or committee that controls the standard?	Volunteer and appointment by national committee
16.	Is voting used to decide whether to modify the standard? If Yes, explain who is permitted to vote.	☒ Yes ☐ No National committees
17.	Is an ANSI-accredited process used to develop the standard?	☐ Yes ☐ No
18.	What countries are represented in the working group or committee that controls the standard?	Too many to list. Current URL http://www.iec.ch/dyn/www/f?p=102:14:0::::FSP_ORG_ID:2400

H. Support, Conformance, Certification and Testing

1.	Is there a users group or manufacturers group to support this standard?	☒ Yes ☐ No
2.	What is the name of the users group or manufacturers group (if any)?	UCA International Users Group

3.	What type of test procedures are used to test this standard? (please check all that apply)	☐ Internal to the lab ☒ Published by standards organization ☒ Published by users group ☐ No procedures, informal testing
4.	Are there test vectors (pre-prepared data) used in testing? (please check all that apply)	☐ Internal to the lab ☐ Published by standards organization ☐ Published by users group ☐ No procedures, informal testing
5.	What types of testing programs exist? (check all that apply)	☐ Interoperability Testing ☒ Conformance Testing ☐ Security Testing ☐ No Testing
6.	What types of certificates are issued? (check all that apply)	☐ Interoperability Certificate ☒ Conformance Certificate ☐ Security Certificate (text document) ☐ No Certificates
7.	Are there rules controlling how and when to use the logo?	☐ Yes ☐ No ☒ Standard has no logo. IEC logo does not imply certification
8.	Is there a program to approve test labs?	☒ Yes ☐ No
9.	Approximately how many test labs are approved (if any)?	there are two categories of test labs approved: A: Vendor independent test labs – 1 approved B: Test labs associated with vendors – approx 3 approved
10.	Is there a defined process for users to make technical comments on the standard or propose changes to the standard and have these issues resolved?	☒ Yes ☐ No
11.	Is there a published conformance checklist or table?	☒ Yes ☐ No
12.	Are there defined conformance blocks or subsets?	☐ Yes ☒ No
13.	Approximately how many vendors provide test tools?	2
14.	Are there tools for pre-certification prior to testing?	☒ Yes ☐ No Must be purchased
15.	Can vendors self-certify their implementations?	☒ Yes ☐ No e.g. with a type B test lab
16.	Is there application testing for specific uses?	☐ Yes ☒ No ☐ Not applicable
17.	Is there a "golden" or "reference" implementation to test against?	☐ Yes ☒ No
18.	Who typically funds the testing? (check all that apply)	☐ User ☐ Users Group ☒ Vendor ☐ Confidential
19.	Is there a method for users and implementers to ask questions about the standard and have them answered? (check all that apply)	☒ Yes, official interpretations ☐ Yes, informal opinions ☐ No

20.	Does the users' group (or some other group) fund specific tasks in the evolution of the standard?	☐ Yes ☒ No except conformance testing
21.	Is the users' group working on integration, harmonization or unification with other similar standards?	☒ Yes ☐ No
22.	What other standards is this standard being integrated, harmonized, or unified with (if any)?	IEC 61968/61970 DNP3 IEC 60870-5
23.	Are there application notes, implementation agreements, or guidelines available describing specific uses of the standard?	☒ Yes ☐ No ☐ Not applicable Guidelines exist from the UCA users group as well as from the standard itself as technical reports (IEC 61850-90-x)

J. Notes

Please present here any additional information about the standard that might be useful:

1.	Used for essentially all new substation development in several places around the world. Many new regions are now starting to adopt the standard. In a first steps, the standard was mainly used for substation automation projects that have been delivered as turn key by one of the major product vendors. Now, the standard is more and more adopted by utilities acting themselves as system integrator. An important requirement for this to be successful is the availability and maturity of engineering tools.

Section II: Functional Description of the Standard

K. GridWise Architecture: Layers

Please identify which layers this standard specifies, as described in
http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf, and the applicable section of the standard. Note the mapping to the Open Systems Interconnect (OSI) model is approximate.

1.	**Layer 8: Policy**	☐ Yes ☒ No #####
2.	**Layer 7: Business Objectives**	☐ Yes ☒ No #####
3.	**Layer 6: Business Procedures**	☐ Yes ☒ No to some extent there is an impact on the engineering process
4.	**Layer 5: Business Context**	☒ Yes ☐ No #####
5.	**Layer 4: Semantic Understanding (object model)**	☒ Yes ☐ No #####
6.	**Layer 3: Syntactic Interoperability (OSI layers 5-7)**	☒ Yes ☐ No #####
7.	**Layer 2: Network Interoperability (OSI layers 3-4)**	☒ Yes ☐ No #####
8.	**Layer 1: Basic Connectivity (OSI layers 1-2)**	☒ Yes ☐ No #####

L. GridWise Architecture: Cross-Cutting Issues

Please provide an explanation in the box beside the heading for any questions answered "Not applicable". If the question is not applicable because the function is provided in another layer or standard, please suggest any likely candidates. Note that "the standard" refers to the technology specified by the standard, not the documents themselves.

	Shared Meaning of Content	#####
1.	Do all implementations share a common information model?	☒ Yes ☐ No ☐ Not applicable
2.	Can data be arranged and accessed in groups or structures?	☒ Yes ☐ No ☐ Not applicable
3.	Can implementers extend the information model?	☒ Yes ☐ No ☐ Not applicable
4.	Can implementers use a subset of the information model?	☒ Yes ☐ No ☐ Not applicable
	Resource Identification	Central management of names is theoretically possible but no tools exist yet.
5.	Can data be located using human-readable names?	☒ Yes ☐ No ☐ Not applicable
6.	Can names and addresses be centrally managed without human intervention?	☐ Yes ☒ No ☐ Not applicable
	Time Synchronization and Sequencing	#####
7.	Can the standard remotely synchronize time?	☒ Yes ☐ No ☐ Provided in another layer
8.	Can the standard indicate the quality of timestamps?	☒ Yes ☐ No ☐ Provided in another layer
	Security and Privacy	#####
9.	Where is security provided for this standard?	☐ Within this standard ☒ By other standards
10.	Does the standard provide authentication?	☒ Yes ☐ No IEC 62351
11.	Does the standard permit role-based access control?	☒ Yes ☐ No IEC 62351

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12.	Does the standard provide encryption?	☒ Yes ☐ No IEC 62351
13.	Does the standard detect intrusions or attacks?	☐ Yes ☒ No but the standard provides means to declare them (object models)
14.	Does the standard facilitate logging and auditing of security events?	☐ Yes ☒ No the elements for the modeling are available. With edition 2, logging of all information exchange is possible
15.	Can the security credentials be upgraded remotely?	☐ Yes ☒ No ☐ No Credentials
16.	Can the security credentials be managed centrally?	☐ Yes ☒ No ☐ No Credentials
17.	Please list any security algorithms and standards used	RSA, SHA, AES, TLS, X.509
18.	Please provide additional information on how the standard addresses any "Yes" answers above	Credentials cannot be managed through IEC 61850 but standard X.509 certificates can be used with a public key infrastructure using other standards
19.	Please provide additional information about why any of the questions listed above do not apply to this standard	
	Logging and Auditing	#####
20.	Does the standard facilitate logging and auditing of critical operations and events?	☒ Yes ☐ No Edition 2 provides features to log all information exchange
21.	Can the standard gather statistics on its operation?	☐ Yes ☒ No ☐ Not applicable Work is being proposed.
22.	Can the standard report alerts and warnings?	☒ Yes ☐ No ☐ Not applicable
	Transaction State Management	#####
23.	Can the standard remotely enable or disable devices or functions?	☒ Yes ☐ No ☐ Not applicable
	System Preservation	#####
24.	Can the standard automatically recover from failed devices or links?	☒ Yes ☐ No ☐ Not applicable ☐ Provided in another layer
25.	Can the standard automatically re-route messages?	☒ Yes ☐ No ☐ Not applicable ☐ Provided in another layer
26.	Can the standard remotely determine the health (as opposed to just connectivity) of devices or software?	☒ Yes ☐ No ☐ Not applicable
	Other Management Capabilities	
27.	Please describe any other system or network management capabilities the standard provides.	#####
	Quality of Service	GOOSE and SMV data can be prioritized
28.	Is data transfer bi-directional?	☒ Yes ☐ No
29.	Can data be prioritized?	☒ Yes ☐ No ☐ Not applicable
30.	What types of reliability are provided?	☐ Reliable ☐ Non-guaranteed ☐ Both ☒ Either ☒ Provided in another layer

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31.	Can information be broadcast to many locations with a single transmission?	☒ Yes ☐ No ☐ Not applicable
32.	Please describe any other methods the standard uses to manage quality of service.	VLANs and Ethernet priorities can be used
	Discovery and Configuration	Supports file transfer
33.	Can the software or firmware be upgraded remotely?	☒ Yes ☐ No ☐ Not applicable
34.	Can configuration or settings be upgraded remotely?	☒ Yes ☐ No ☐ Not applicable
35.	Can implementations announce when they have joined the system?	☒ Yes ☐ No ☐ Not applicable
36.	Can implementations electronically describe the data they provide?	☒ Yes ☐ No ☐ Not applicable
	System Evolution and Scalability	#####
37.	What factors could limit the number of places the standard could be applied?	Bandwidth. The standard has not yet been demonstrated to be suitable for feeder communications. GOOSE and SMV cannot currently be routed but this is in preparation.
38.	What steps are required to increase the size of a system deploying this standard?	Internet protocol devices like routers and bridges.
39.	Is the information model separate from the transport method?	☒ Yes ☐ No
40.	Does the standard support alternate choices in the layers(s) below it?	☒ Yes ☐ No ☐ No layers below
41.	List the most common technology choices for layers implemented below this standard	ISO/IETF protocols, Ethernet vs. wireless or other physical layers supporting Ethernet like SONET/ATM/Frame Relay
42.	Does the standard support multiple technology choices in the layers above it?	☐ Yes ☐ No ☒ No layers above
43.	List the technologies or entities that would most commonly use this standard in the layer above	#####
44.	Please describe any mechanism or plan to ensure the standard is as backward-compatible as possible with previous versions	Devices are self-describing and optionality is permitted, with "name space" designations to indicate versions. IEC 61850 has an XML-based configuration language that identifies standard version. No formal commitment to backward-compatibility, however.
45.	Please describe how the design of this standard permits it to be used together with older or legacy technologies	Specifications being developed for interface with DNP3. Specification available for interface with IEC 60870-5
46.	Please describe how the design of this standard permits it to co-exist on the same network or in the same geographic area with similar technologies, and give examples	Layered protocols make it able to exist with any IP-compatible technologies.
47.	**Electromechanical**	N/A

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M. Architectural Principles
Please describe how this standard may apply any of these principles:

1.	Symmetry – facilitates bi-directional flow of energy and information	All communications are bidirectional.
2.	Transparency – supports a transparent and auditable chain of transactions	Client/Server model uses requests and responses.
3.	Composition – facilitates the building of complex interfaces from simpler ones	Object model is compositionally based – models are built from smaller components.
4.	Loose coupling – can support bilateral and multilateral transactions without elaborate pre-arrangement	Supports self-description of data by devices.
5.	Shallow integration – does not require detailed mutual information to interact with other components	Supports self-description of data by devices. Permits automated configuration through standard XML file formats.
6.	Please list any other architectural models, reference architectures or frameworks this standard was designed to be compliant with, e.g. W3C, IEC TC57, OSI and how it fits those models	Based on ISO/OSI Model and included in TC57 Reference Architecture.